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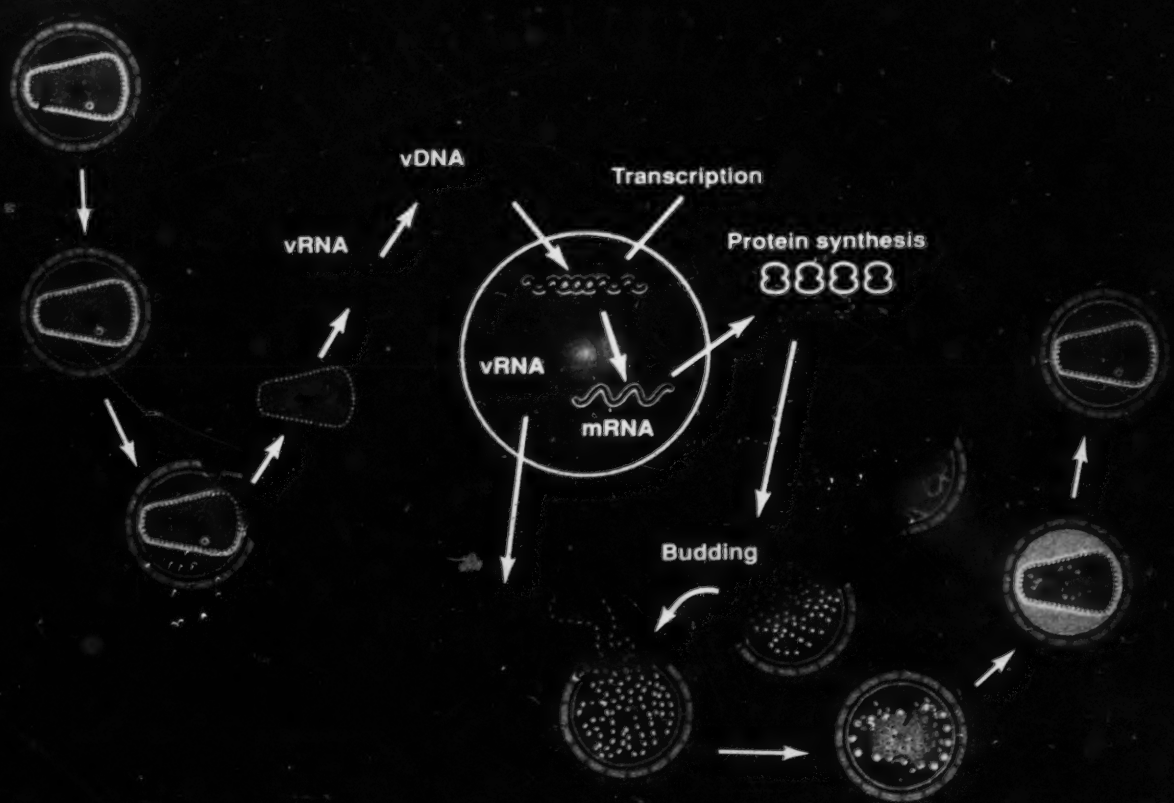
CHEMICAL & ENGINEERING NEWS

C&EN

AUGUST 24, 1992

GURING INDUSTRIAL ACTIVITIES TO PREVENT GLOBAL CHANGE PAGE 7



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CHEMICAL & ENGINEERING NEWS

C&EN

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LETTERS

UV alternative to chlorine

The report (C&EN, July 13, page 7) on the cancer risk associated with chlorinated drinking water from surface water sources cited Robert D. Morris' comments on the need for more effort to study the alternatives to chlorination. I suggest that we currently have sufficient knowledge to design drinking water treatment systems capable of delivering water that is safe from both pathogens and chemical by-products. Use of ultraviolet (UV) light is a physical disinfection method that is a better virucide than chlorine, inactivates microbes within seconds, requires no large retention tanks, is safe for operators and the community, introduces no residuals into the environment, and leaves no undesirable by-products at the disinfection doses used.

Ironically, North America has taken a leadership role in using UV systems of the type pioneered by Trojan Technologies Inc. for disinfecting wastewater (a greater technical challenge than drinking water disinfection); however, the Europeans have been quicker to recognize the advantages of UV for their municipal drinking water systems and are just now embracing UV for wastewater disinfection. Surface water treatment processes that use UV effectively have been developed, and many large European communities are even free of chemical residuals in their thousands of kilometers of distribution lines.

Even without making major changes in North American surface water treatment processes, UV disinfection of filtered surface water followed by chloramination for a residual would be a preferred strategy over chlorination for by-product control. Chloramination would also be more effective on distribution line biofilms than chlorination.

Several water- and wastewater-oriented national organizations in the U.S. are directly or indirectly supporting research on UV disinfection. Continuing research is always important, but what may be needed even more before we see widespread adoption of disinfection alternatives is the same as is needed in all areas of technology evolution: professional leadership by scientists, engineers, consultants, and policymakers in searching out and assimilating the best ideas to resolve our current problems, and then having done that, leadership by these professionals in breaking with tradition to bring these ideas to bear on the problems. The best available technology is not always the long-standing traditional technology against which new technologies are compared.

William L. Cairns
Research Manager
Trojan Technologies Inc.
London, Ontario, Canada

Arrogance in New Jersey

How can business leaders be so out of touch with political realities? I was amazed as I read your report on the Chemical Industry Council of New Jersey (C&EN, July 20, page 6). The lead item in their plan to improve the "hostile" climate for New Jersey chemical firms is to defeat the state's proposed form of initiative and referendum.

I am sympathetic to the industry's concern over the state's aggressive prosecution of environmental laws and regulations. I am sympathetic with their concern over the cumbersome provisions of the right-to-know legislation. Many of their proposals make sense. What I am not sympathetic with is their arrogance for the opinions of the people of New Jersey.

The chemical industry is in this mess because the people believe that the industry has abused the air, soil, water, and health of the people of New Jersey. Despite all of the jobs lost in the industry in New Jersey, chemists seem to be able to find jobs in the rapidly expanding pharmaceutical and biotechnology industries in the state.

Corrections

- Aug. 10, page 6: The Conference Board reported that the growth rate for gross domestic product slowed down to 1.4% in the second quarter, not that GDP fell 1.4%.
- Aug. 17, page 77: The speaker's name for the September ACS Lehigh Valley Section meeting should have been listed as Thomas J. Bzik, Air Products & Chemicals Inc. For more information on this meeting, to be held Sept. 18 at Lafayette College, Easton, Pa., call Charles Nutaitis, (215) 250-5218.

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University Technology Moves to Market via Patenting, Licensing

■ ***Licensing deals with industry have climbed and have led to new products, but schools aren't getting rich***

Ann M. Thayer,
C&EN Northeast News Bureau

Industry's interest in academic research is on the rise, as is universities' desire to see commercial development of their research inventions. In addition to collaborative R&D, academia and industry have been joining forces through licensing of university technologies, much of it chemically related. However, a few major products and lucrative licensing agreements may have raised university expectations, leading some industrial observers to suggest that universities have become more covetous in wanting to make money and more shrewd in trying to do so (C&EN, Feb. 3, page 9).

Despite concerns to the contrary, however, universities don't seem to be getting rich from such licensing deals, nor have business interests superseded universities' mission of research and education.

A striking example of the connection between universities and industry is biotechnology companies. Rarely can one be found without its core technology based on a licensed university discovery, its founders being university researchers, its scientific advisory board packed with faculty members, or a portion of its research conducted under contract in university laboratories. The increasing number and strength of scientific and financial associations between business and academia continues to raise serious conflict-of-interest issues.

Many universities with technology to license have hired technology managers, who must balance academic, business, legal, and ethical issues. Discussions with some of these managers confirm that because of heightened concern, university-business relationships are being watched and managed more carefully, and strict guidelines are being put into effect. They further affirm that, concerning the mission of universities, education and publishing still take priority over industrial-related research and patenting. In terms of monetary returns from licensing, probably less than 1% is recouped on the billions spent on research. In fact, most technology managers interviewed say there is still a need to increase the awareness on campuses of the commercial potential of, and protecting of, university-based inventions and technologies.

Despite this lack of awareness, data that measure university patenting and licensing activities indicate tremendous growth during the past decade. Since 1986, the number of patents awarded to U.S. universities has more than doubled, reaching 1346 in 1991, according to data compiled for the Association of University Technology Managers (AUTM). Patents are a good measure of the marketability of university technologies, since a school is unlikely to incur the expense of patenting an invention unless there is a licensee lined up. And, licensees are reluctant to take the risk of developing an embryonic university technology unless there is some promise of exclusivity.

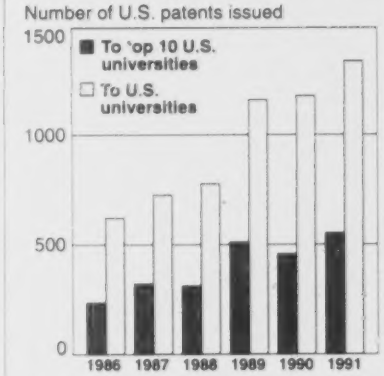
"If you don't have a licensee, patent filing is money at risk and it mounts up very, very quickly," says Lita Nelsen, associate director of the Technology Licensing Office at Massachusetts Institute of Technology. Filing costs alone are about $10,000 per patent, she says. MIT has about $2 million per year at risk in patent costs for technologies that are not yet licensed. "That's a factor of 10 to 50 times more than most schools can afford to do," she says. "MIT won't get its money back on every one, but has the licensing experience to know that statistically it is making the right judgments."

Not all schools have the expertise or income flow to allow them to do this. MIT, Stanford, and the University of California system each may set up several dozen licensing agreements in a year, accounting for nearly half of all university licenses and income. MIT has one of the most experienced and most active licensing offices, having been set up 60 years ago. License fees average $10,000 to $50,000 per year, whereas royalties may be a few to several percent of sales.

In fiscal 1991 ending June 30, MIT had licensing and royalty income amounting to $4.4 million and is projecting about $5.5 million for 1993, which is enough income to cover expenses, says Nelsen. Fiscal 1992 was an anomaly, she adds, because the licensing office brought in more than $15 million, about $9 million of which came from a one-time gain. "A number of startup companies in which MIT had tiny bits of equity took advantage of the initial public offering window last October, and . . . in many cases MIT sold [its interest]."

It is not MIT's policy to invest its money in new companies, although the university may take an equity interest partially in lieu of licensing or royalty income and has done so for about 15 companies. Like most schools, it generally keeps such interests at a very low lev-

Patents to universities doubled in past six years



Source: Ronald T. Coslick Jr., University of Buffalo, for Association of University Technology Managers

el, under a few percent. MIT's equity interests also are very "passive," explains Nelsen, meaning that the university does not get involved in the operations of the company or take a seat on its board of directors. Many universities also have restrictions on whether faculty members can be company officers.

About 35 to 40 companies, including ImmuLogic, Interneuron, and American Superconductor, are based on technologies licensed from MIT. The single most active area of licensing has been biotechnology, says Nelsen. But, unlike many other schools, biotechnology accounts for only about one third of licensing activity, rather than a significant majority. This results partly from MIT's not having a medical school or hospital affiliation. However, the university does actively license in the areas of materials, computers, semiconductors, lasers, and electronics.

"Biotechnology is the area in which university-industry relations are the strongest," says Katharine Ku, director of Stanford's 23-year-old Office of Technology Licensing. Many emerging biotechnology companies license early-stage technologies from universities and then add value, she explains, putting more research effort into developing technologies further. Quite often, these small companies then will try to license the technology or product to a major pharmaceutical company for marketing. Some examples of successful products licensed for marketing include human insulin, α-interferon, and hepatitis B vaccine.

"All the interests of the parties involved are really well served with this kind of staging," she says. "Most major pharmaceutical companies are more interested in a more developed product than that which comes out of a university, and universities don't have the resources or the interest in trying to put more development effort into their basic invention."

The primary goal of licensing university technology is not to make money, stresses Nelsen of MIT, but to get the technology developed, a sentiment echoed by other university technology managers. "If people are in this for the money, they are in the wrong ball game," she says. As president of AUTM, Nelsen says that the organization's growing membership, which is nearing a thousand, is indicative of the rise in technology licensing.

Most universities making significant amounts of money, year-to-year profits in the millions, are those that have licensed a single blockbuster patent—such as the patent on genetic engineering shared by Stanford University's Stanley N. Cohen and the University of California's Herbert W. Boyer, the University of Wisconsin's vitamin D patent, and Michigan State University's cisplatin patent. "Clearly you don't run a business on hitting the lottery," she says, but adds that having an active licensing effort is important to take advantage of the "once in a decade" inventions when they arise.

Some universities, such as MIT and the University of California system, are starting to build license portfolios that bring a more regular income to support licensing activities. There often is a significant lag time, as much as 10 to 15 years, between discovery and an invention becoming an income-generating product. Licensing income for the fiscal year ending June 30 1992 was $31.3 million, up 41% from a previous record year in 1991, for the UC system. A factor contributing to the dramatic increases in income from just a few million dollars 10 years earlier is royalties being generated from "older" inventions. However, no single invention among the hundreds UC has licensed accounts for a majority of its licensing income. Although this is considered healthy, it is atypical.

Another factor has been a restructuring of UC's licensing efforts to be more "marketing oriented toward industry and service oriented toward faculty," says Carl Wootten, director of the UC system's Office of Technology Transfer. Wootten's office has oversight over the nine UC campuses as well as three national laboratories managed by the university. The UC system has offices or liaisons at each of its nine campuses, although Berkeley, Los Angeles, and the federal laboratories are large enough to be responsible for their own licensing efforts. UC's nine campuses represent more than $1.3 billion in R&D spending, or more than 10% of research spending among the top 100 U.S. institutions. Its licensed inventions are in a wide range of areas, including biotechnology, drugs, electronics, sensors, and superconductors.

Stanford University's biggest money earner is the 1980 Cohen & Boyer patent that is licensed to 180 companies, including most major biotechnology and pharmaceutical companies. About 70% of its $25.6 million in licensing and royalties income in 1991 came from this patent, says Ku, which it shares with the UC system. Stanford gets both licensing fees and royalties on products made through genetic engineering, whereas Boyer went on to become a founder of Genentech. Although not interested in starting new companies, Stanford does consider taking equity as another possible form of compensation.

Although the sum from its technology licensing sounds like a huge number, says Ku, it occupies only a niche, and an uncertain one at that, in terms of university finances. "The university cannot rely on technology licensing for operating revenues," says Ku. "As an example, the Cohen & Boyer patent has a life of 17 years, and so in 1997 that income is just going to drop to zero."

Coincident with much of the early growth in biotechnology, it became possible under a 1980 federal law for universities to hold rights to inventions developed with government money. It is rare that a university invention does not involve

MIT leads in U.S. patents awarded to universities

	Number of U.S. patents issued in 1991	R&D spending in 1990[a] ($ millions)
Massachusetts Inst. of Technology	105	$ 312
U of California	87	1344[b]
U of Texas	83	405[c]
Stanford U	57	306
U of Wisconsin	45	310
U of Florida	44	140
Cornell U	41	300
Iowa State U	38	116
California Inst. of Technology	36	106
U of Minnesota	31	292
State U of New York	26	191[d]
Johns Hopkins U	26	669[e]
U of Michigan	22	311

a Some figures include spending at associated federally funded centers. b Santa Cruz campus not included. c Austin, M. D. Anderson Cancer Center, and SW Medical Center-Dallas. d Buffalo and Stony Brook campuses. e Includes Applied Physics Laboratory with $416 million in R&D spending. **Sources:** Ronald T. Coslick Jr., University of Buffalo, for Association of University Technology Managers; National Science Foundation

Boston University's investment in Seragen raises questions

Universities may take equity interests in startup companies in return for granting them rights to university technologies. In most cases, the level of investment in a single company is kept low, or investments are spread among different companies to minimize risk. An exception to this practice that has generated a great deal of attention is Boston University's majority interest in Seragen, a biotech company headquartered in Hopkinton, Mass., that develops fusion toxins for treating cancer and autoimmune diseases.

In 1990, Boston University's holdings in Seragen made headlines when university president John R. Silber unsuccessfully ran for Massachusetts governor. The university's interest was used as an example of questionable fiscal management whereby a significant amount of university monies were invested in a company that, like any development-stage biotechnology company, has an uncertain future. From 1987 until the company's initial public offering of stock this April, Seragen's primary source of operating funds, amounting to about $1 million per month, was Boston University. Although its interest was diluted and its risk somewhat decreased with the public offering, the university still holds a sizable 69% stake.

Boston University founded the company as a joint venture with members of its scientific faculty in 1979. The company holds license to technology developed by John R. Murphy, affiliated now with Boston University and formerly with Harvard. As a founder of Seragen, Murphy currently serves as both a director and paid company consultant. Silber and others from Boston University serve on the company's board of directors.

Although the university can elect a majority of the company's directors and control its corporate actions, Boston University has not been obligated to guarantee or provide funding to the company since the stock offering. Occurring at a low point for biotechnology stocks, the offering raised only $36 million, and Seragen will have to seek funds from other sources because it has no product sales. Analysts who view the company's science positively believe the company can succeed in raising money.

The university's 69% interest is worth $72.5 million at current stock prices, a figure less than the university has invested in the company, and reportedly equivalent to about one third of Boston University's endowment. In addition, the value of its investment has decreased 27% from what it was at the time stock was offered to the public. Under an agreement with the company, the university is restricted in the number of shares it can sell for about one year after the initial stock offering.

As a charitable institution, Boston University's investments fall under review and monitoring by the state attorney general, who could force the university to sell all or part of its stock. However, doing so is tied up with complicated questions relating to conflicting interests of the company and university. For example, if it were considered to be in Boston University's best interest to cut its risk by decreasing its holding, doing so might harm the company by causing investors to lose confidence. And, if stock prices fell, this could have negative repercussions on any remaining university investment in Seragen.

Boston University has been an extraordinarily committed, long-term investor, says Richard C. Svrluga, president and chief executive officer of Seragen. The university has told the company that it does not intend to sell its stock in the near future. Therefore, the university must wait and see whether Seragen will be successful in bringing products to the market and whether the potentially sizable return on its investment will come from royalties to be paid on product sales.

government funding, says Joyce Brinton, director of technology and trademark licensing at Harvard University, since an average of about 60% of university research funding comes from government sources. Before the law, inventions were owned by the government and offered for nonexclusive licenses or not licensed at all, falling into the public domain.

One of the goals of the law, which some university technology managers believe has been borne out by experience, was to provide a mechanism that would promote the development of these technologies through a promise of exclusivity for companies and by providing an incentive for universities. Although the law has been hotly debated, its effect has been clear with the growth in number of university patents and in new products that have originated from university research. "For a lot of university inventions, one has to have a lot of imagination before one can see what the product is going to be," says Brinton. "But in the biotechnology area, that distance seems to be somewhat shorter."

Contributing to the incentive for licensing, says Brinton, is that "government research funding is becoming a little tighter and so the possibility of generating some additional money from research to support research becomes increasingly important." However, technology managers do not expect that licensing income will replace, or even approach, that from other sources of support.

Because sufficient funds are not available to the licensing office, Harvard does not have a policy of investing in companies, "Harvard is talking about ... whether the university should feel free or not to take equity in situations where it feels that it is appropriate and there will not be undo conflict," says Brinton. "At the moment our practice in general, although it is not a stated policy, is that we don't take equity in companies."

However, a few years ago its medical school took $30 million seed capital and set up a venture capital investment group called Medical Science Partners. Medical Science Partners itself has established about 10 companies, says Brinton. Along with its medical school, Harvard has been the source of many licensed technologies and faculty members who have founded startup biotechnology companies, among them Genetics Institute and Biogen.

Revenue from its licensing program is about $4.5 million on research spending of $285 million. The best way to establish the value of a university discovery is through a negotiation process, she explains. "We have to test the marketplace to see what it is actually worth, as in the end we can only get what somebody is willing to pay."

Opinions vary greatly as to the value that should be assessed to university technologies. "There is a lack of realism on

both [university and industry] sides," adds Nelsen of MIT. "There are very, very strong opinions on whether universities are realistic in asking to be recognized as unique resources or whether they are getting greedy and unrealistic. [MIT's] view is to recognize that the technology is very embryonic and is going to require a lot of development." Thus, the university tries to work out arrangements with companies that will share both the risk and the rewards. Large companies tend not to be so interested as small companies in licensing embryonic technologies.

"In some instances, universities dealing with their own intellectual property sell it too cheaply," says Gary Munsinger, president of Research Corporation Technologies (RCT), a Tucson-based technology licensing firm. "And sometimes, on the other hand, they may be unrealistic in their expectations of what they should receive." RCT is in the business of evaluating, patenting, and licensing university technologies and provides services to many smaller universities that don't have the money, expertise, or breadth of research to support a licensing office. In 1991, it worked with 113 participating institutions.

Munsinger believes that a university must have R&D spending of $250 million to $300 million per year to warrant a full-service licensing program. "To have the critical mass of expertise to cover [licensing]," says Munsinger, "you've got to have a fairly sizable operation at a university and you have [to have] great scope and depth of research to justify economically the staff that would be required to do what we do."

Universities always have more opportunities for employment of their resources than they have resources, and technology licensing may require taking discretionary funds from other activities. "It comes down to the question of how well [a university] can do this technology transfer business if there are other demands on its resources," Munsinger adds. "Can it really afford to create a critical mass of talent dedicated solely and exclusively to that function?"

Because it is profitable, RCT has its own money to invest in developing technologies prior to licensing or in starting up companies or joint ventures, unlike most universities. In 1991, RCT brought in $43.3 million in revenues from licenses and royalties, an increase of about 34% from the previous year. Of that, $28.2 million, or 65%, was distributed to institutions and inventors. After expenses, RCT had a net profit of $1.19 million, down 68% from the previous year because of higher than anticipated litigation costs related to patents.

RCT uses a market approach and tries to rapidly assess the potential value of university intellectual property on a case-by-case basis, as it had for the fullerenes. In 1991, 635 new disclosures were screened, with 221 of those in life sciences and 407 in physical sciences. If an invention has commercial potential, RCT will apply for patents—including patents in foreign countries, which many universities won't do because of the added expense—and will develop a commercialization plan with which to approach the best companies for licensing. □

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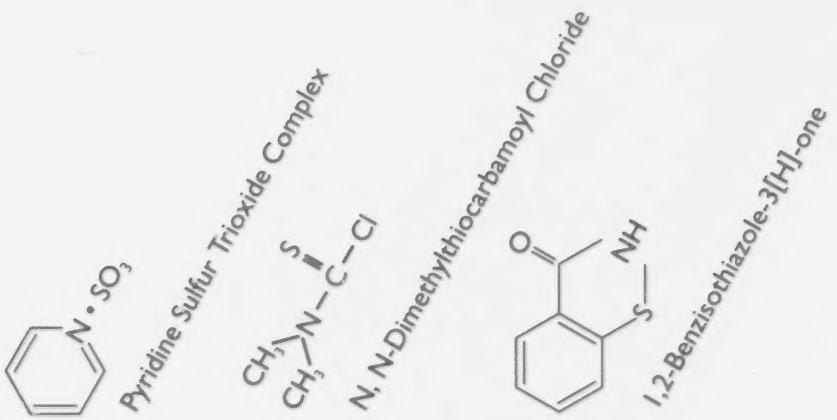

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